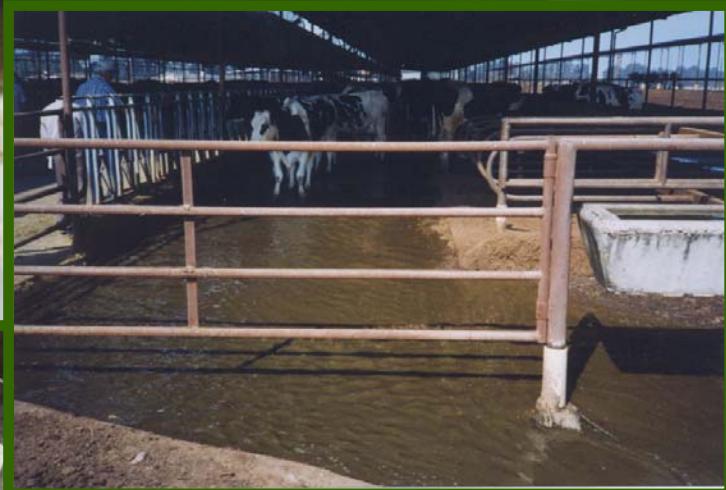


Release of *Cryptosporidium* and *Giardia* (Oo)cysts From Dairy Calf Manure: Impact of Solution Salinity

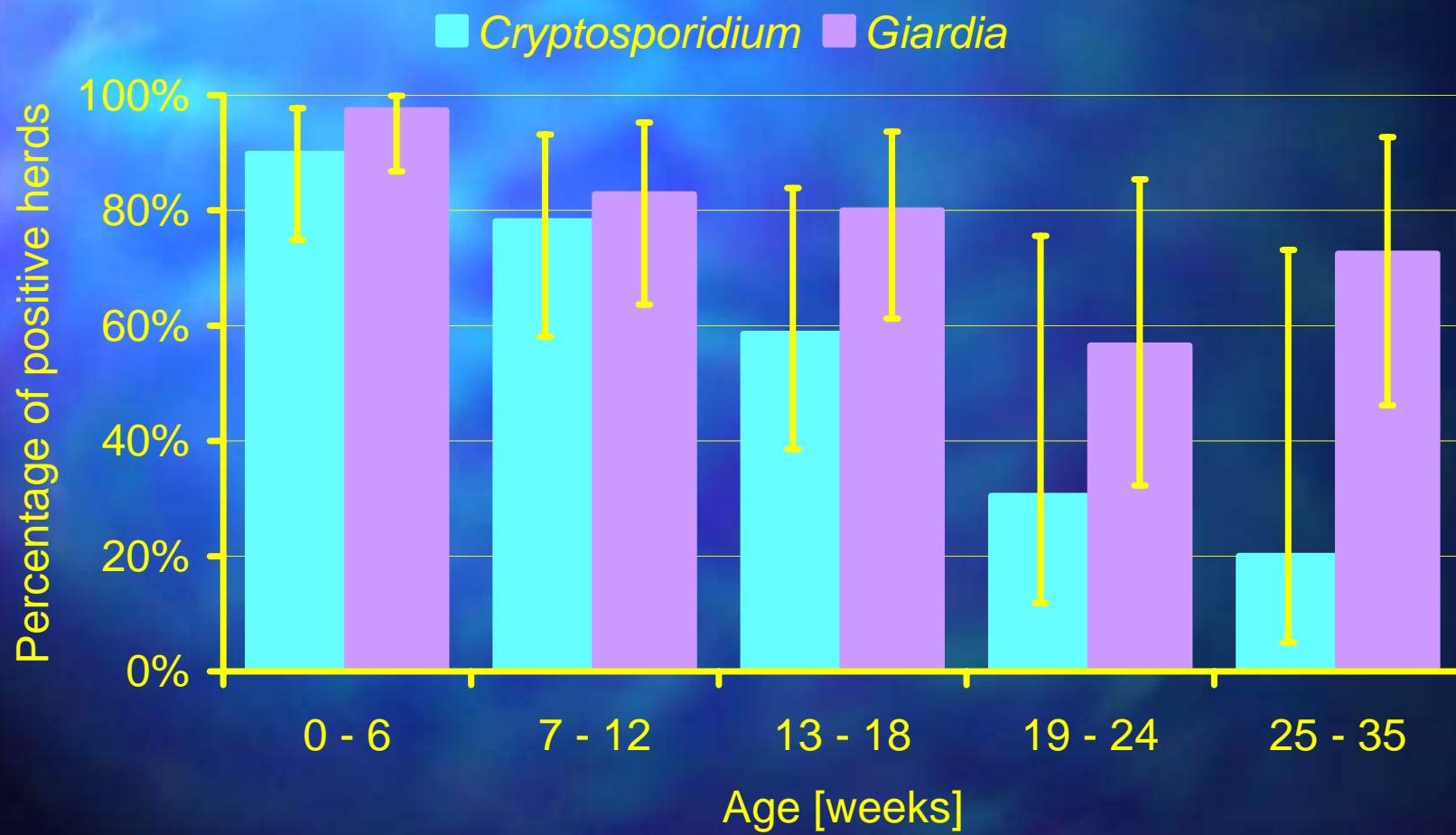
Scott A. Bradford¹ and Jack F. Schijven²

¹George E. Brown, Jr., Salinity Laboratory
USDA, ARS

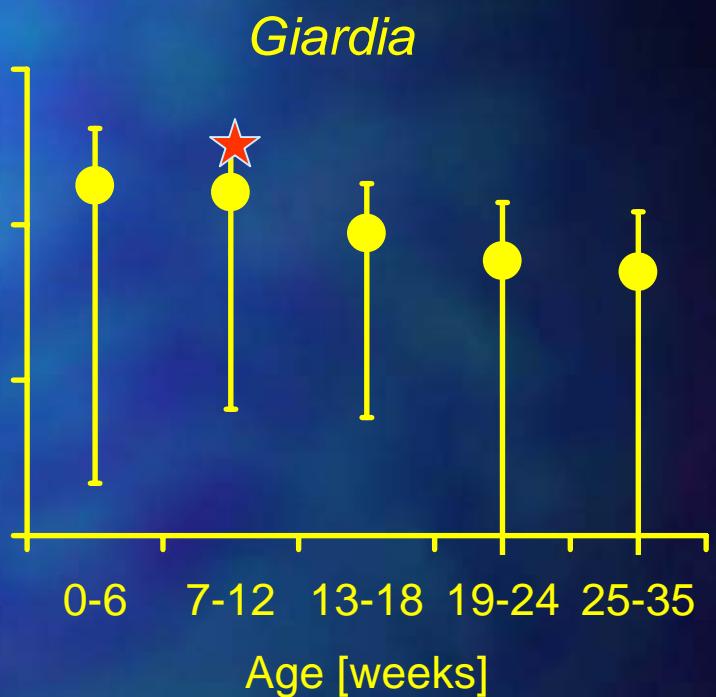
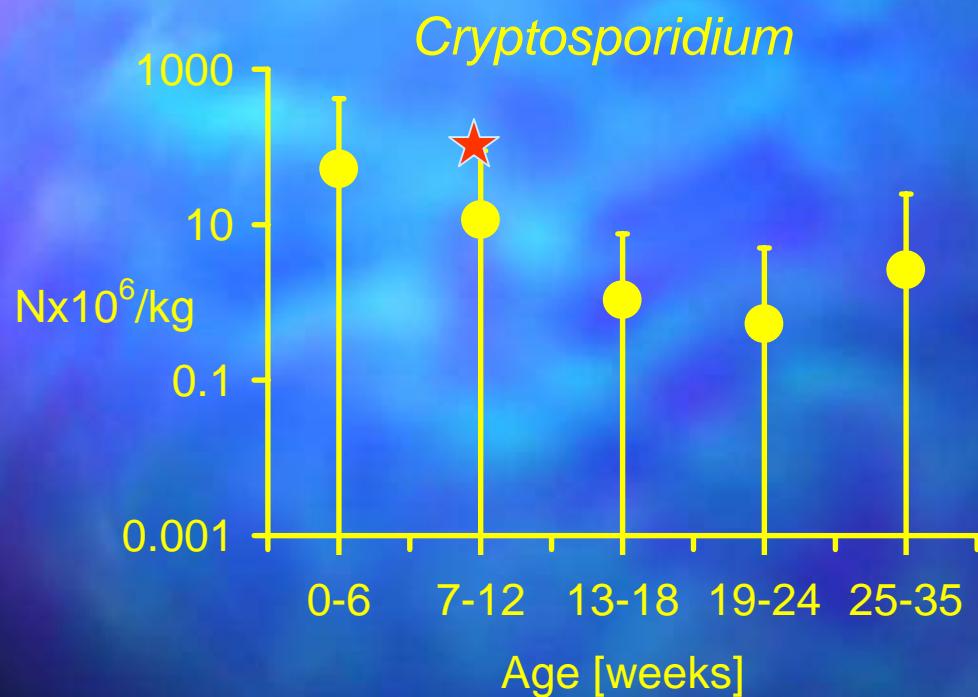
²National Institute of Public Health and the Environment (RIVM)
Bilthoven, The Netherlands



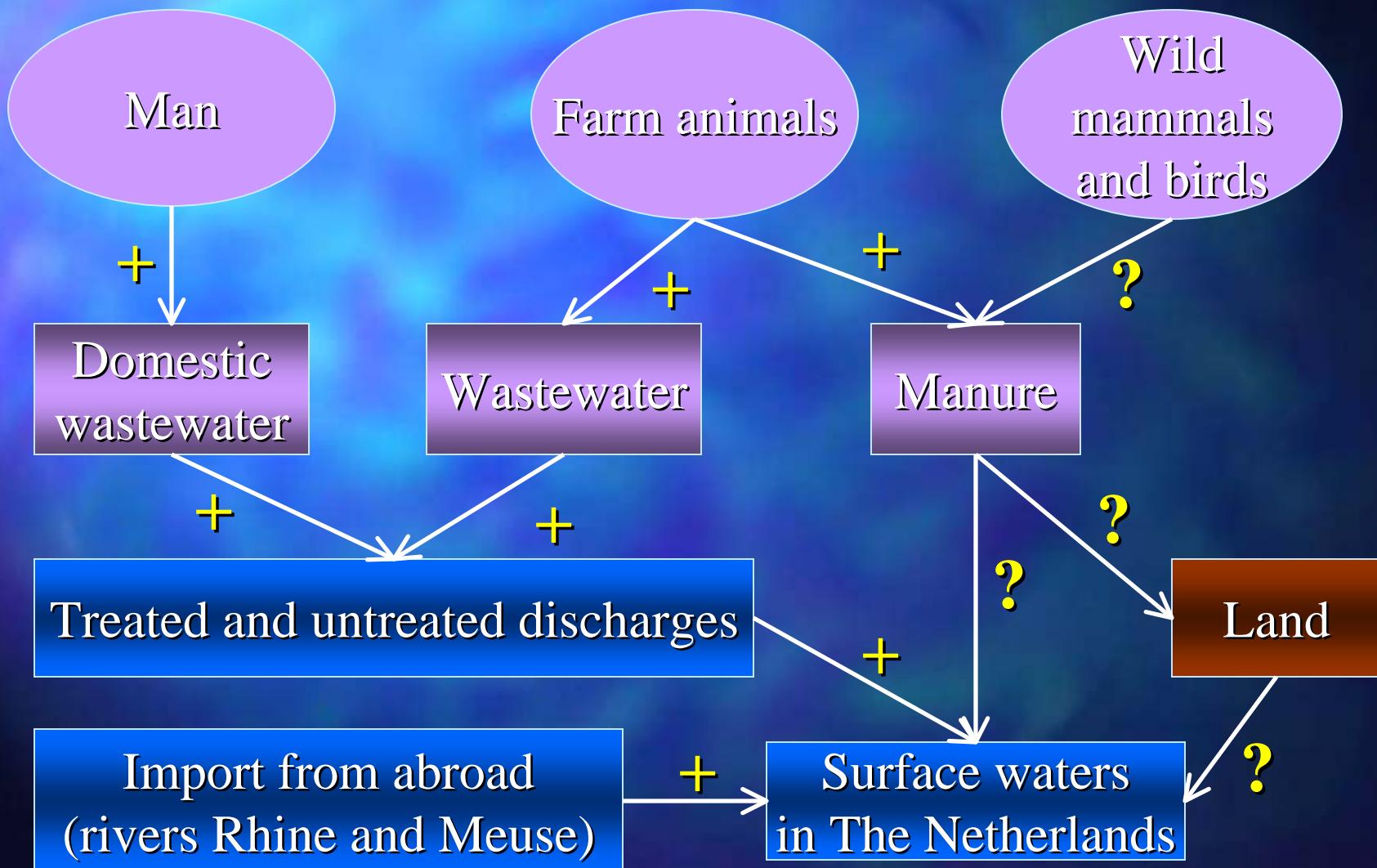
Prevalence in herds of veal calves versus age of veal calves



Average concentrations in positive samples of fresh manure from veal calves versus age



Major pathways of *Cryptosporidium* and *Giardia* to surface waters in The Netherlands



Introduction

- Cattle manure, especially from calves, form an enormous source of *Cryptosporidium* and *Giardia*.
- Due to animal waste application to agricultural land, large numbers of (oo)cysts may reach groundwater and surface water.
- Release rates of (oo)cysts from manure are important boundary conditions for loading rates into the environment.
- Manure is exposed to a wide range of solution salinities (rain or urine).

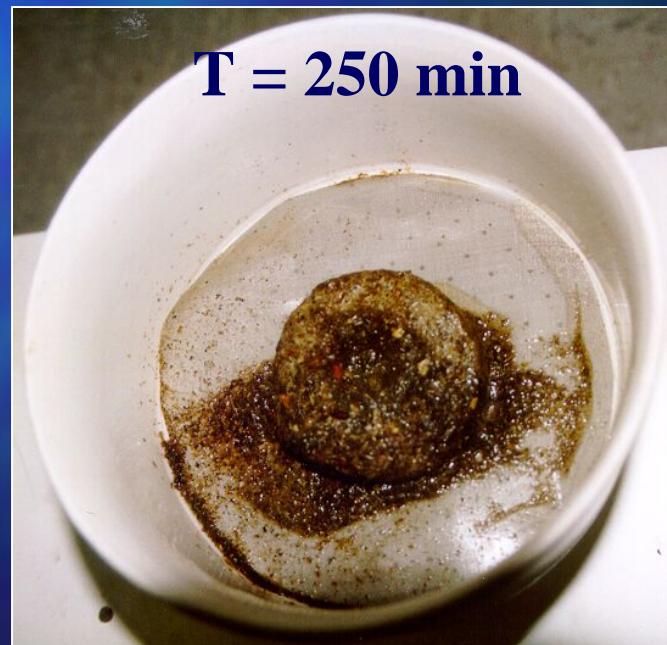
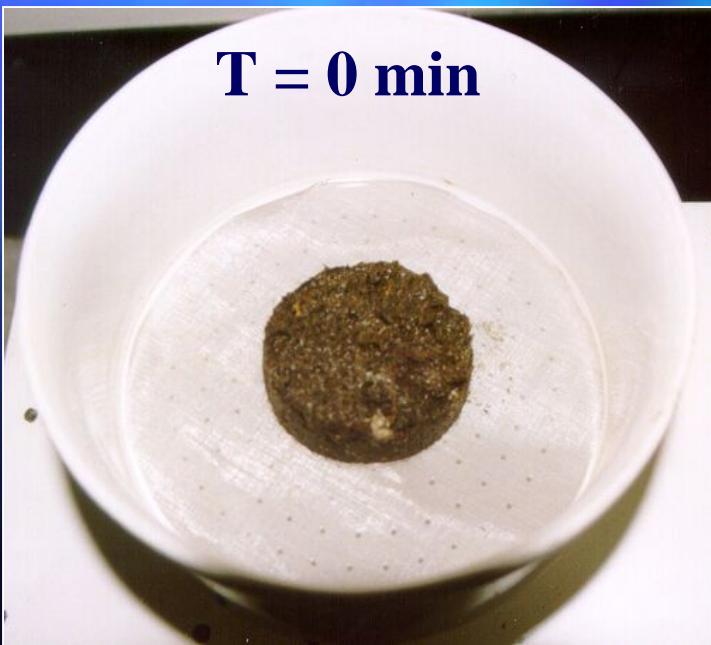
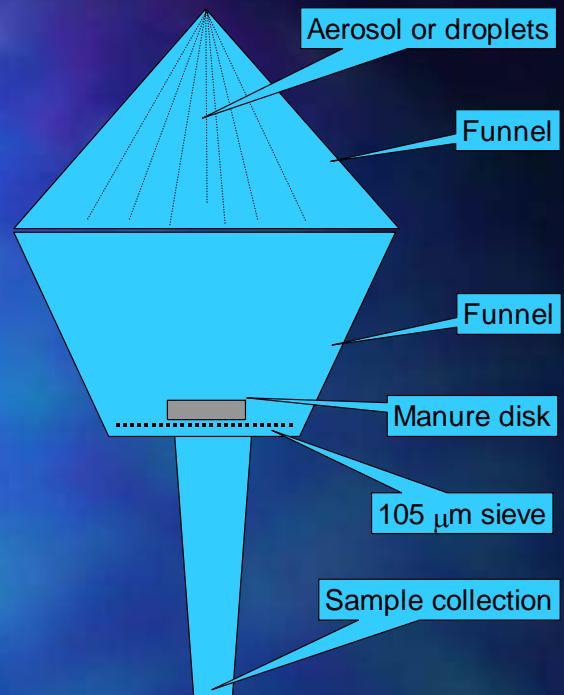
Holstein dairy cattle (Chino, CA)



Manure phase concentrations of (oo)cysts, m_{ip} , N g⁻¹.

	<i>Cryptosporidium</i>	<i>Giardia</i>
Average	7.1×10^4	9.5×10^4
S.D.	1.7×10^4	3.0×10^4
N	6	12

Manure Drip Experiments



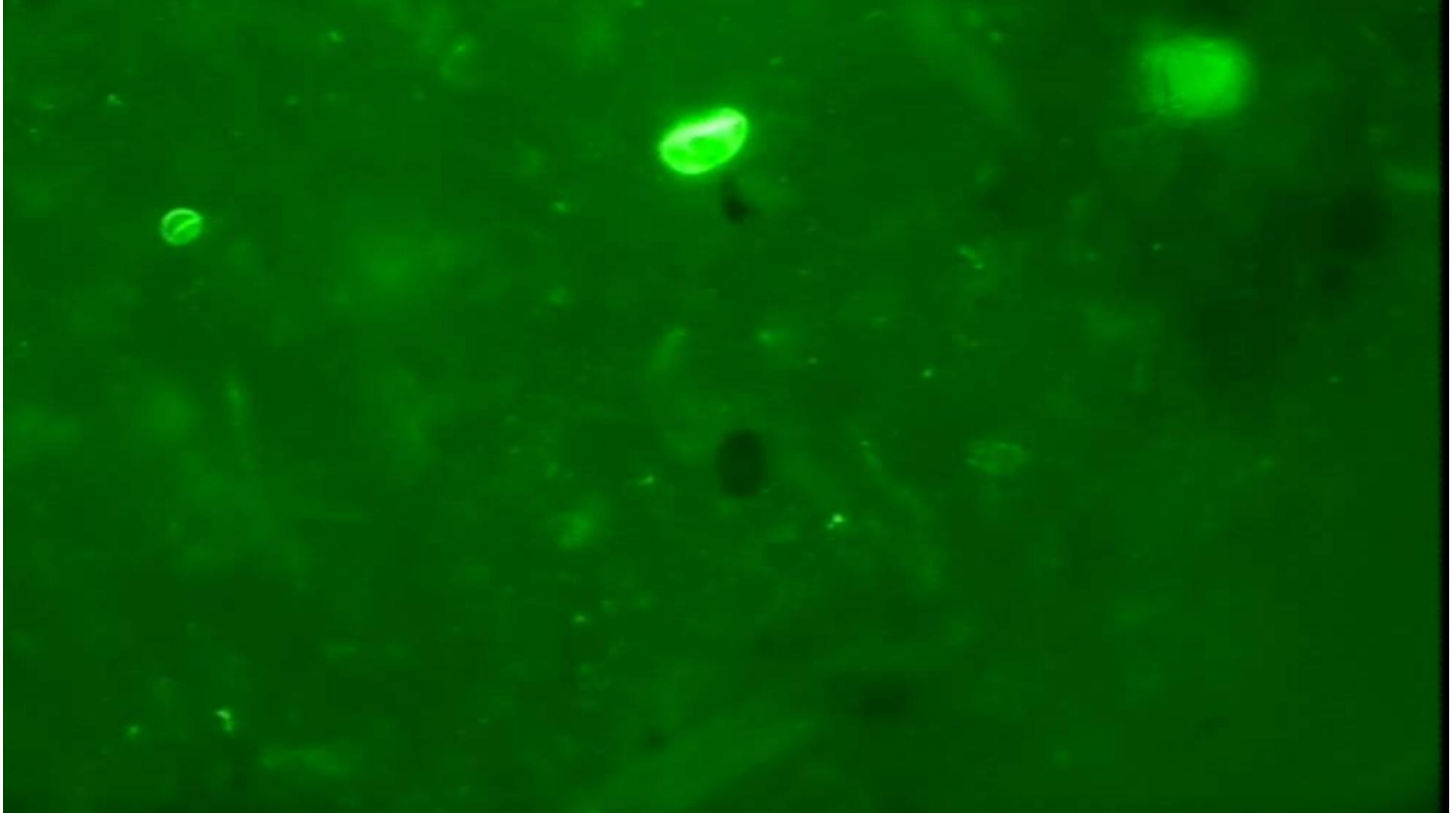
Experimental conditions

Manure	Water application	Q [ml min ⁻¹]	EC [dS m ⁻¹]	Temp. [°C]
Calf	Mist	10	0.3	5
Calf	Mist	2.9	0.3	5
Calf	Drip	2.4	0.3	5
Calf + Cow 1:10	Drip	2.7	0.3	5
Calf + Cow 1:1	Drip	3.0	0.3	5
Calf	Drip	2.6	0.3	23
Calf	Drip	2.0	0.3	23
Calf	Drip	2.5	5.0	23
Calf	Drip	2.0	9.5	23
Calf	Drip	2.1	15	23

$\rho_i = 1.1 \text{ g cm}^{-3}$ from Vm (34.4 ml) and initial weight of manure disk (g).

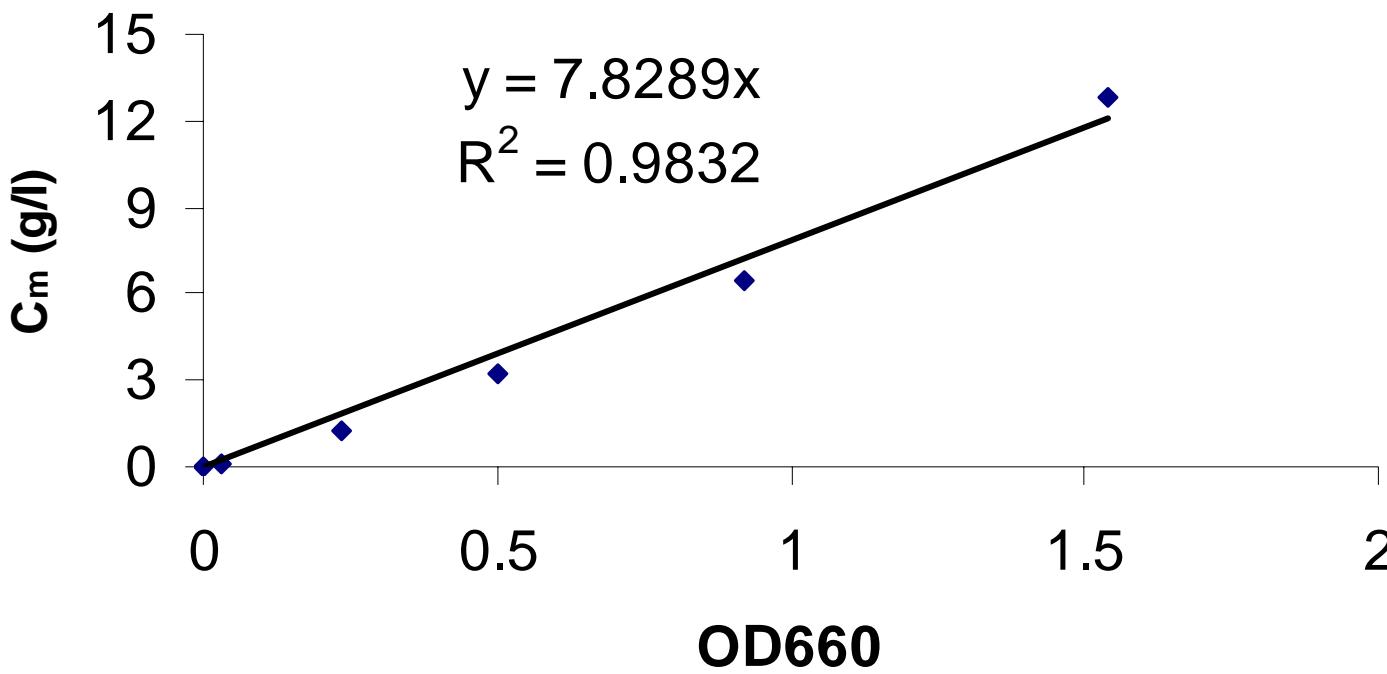
Detection of *Cryptosporidium* and *Giardia*

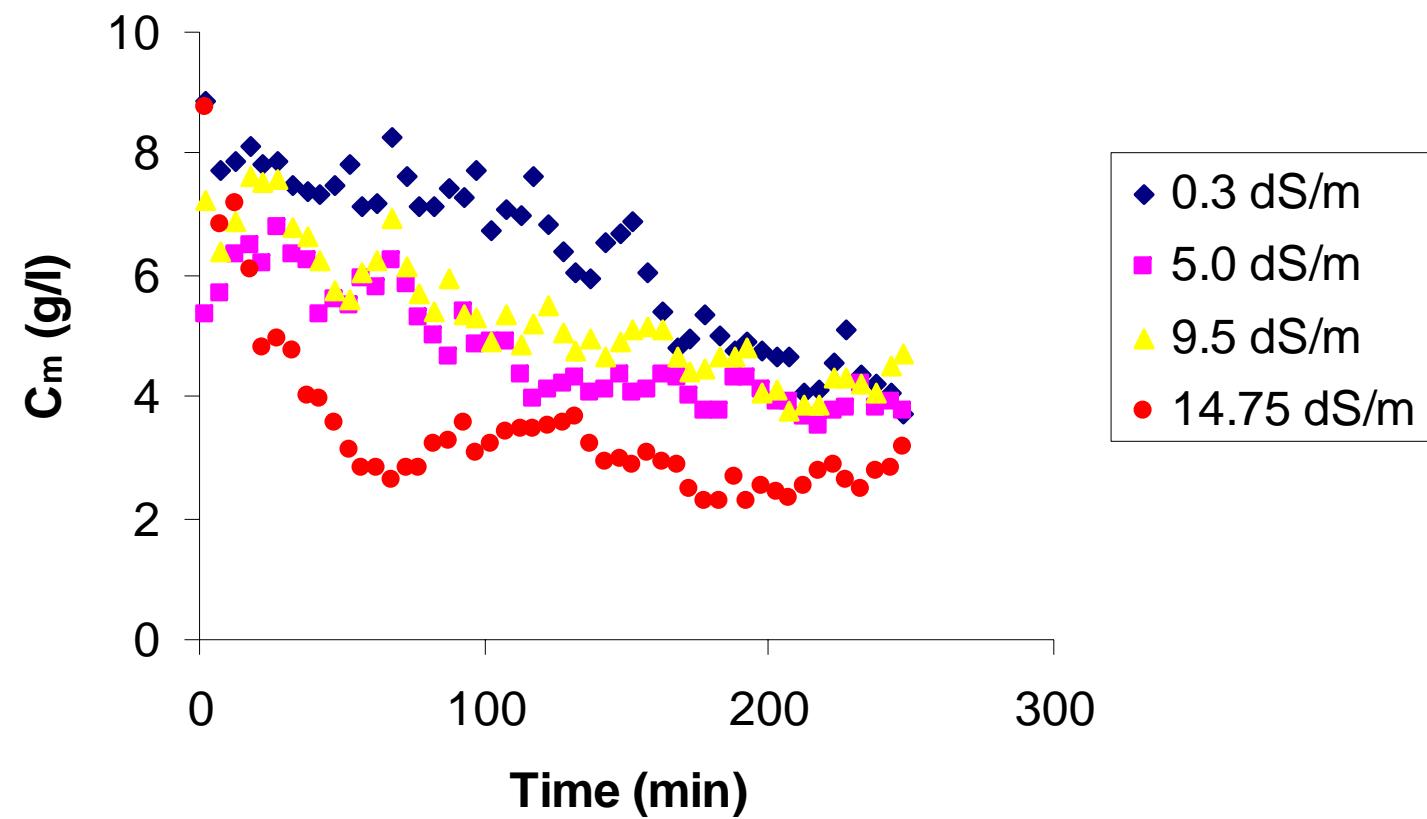
- FITC - Monoclonal Antibody
- Direct Enumeration via Microscopy

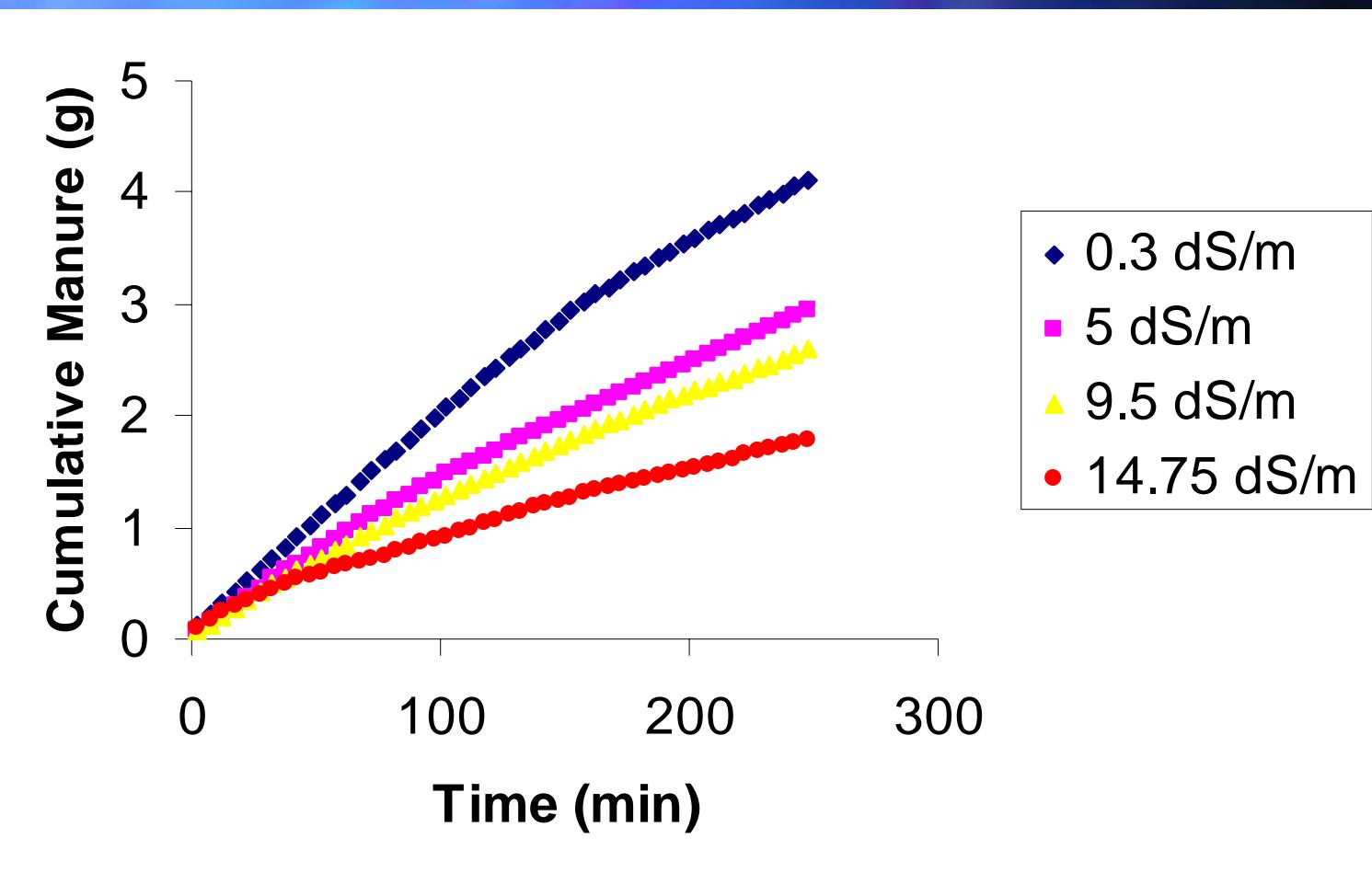


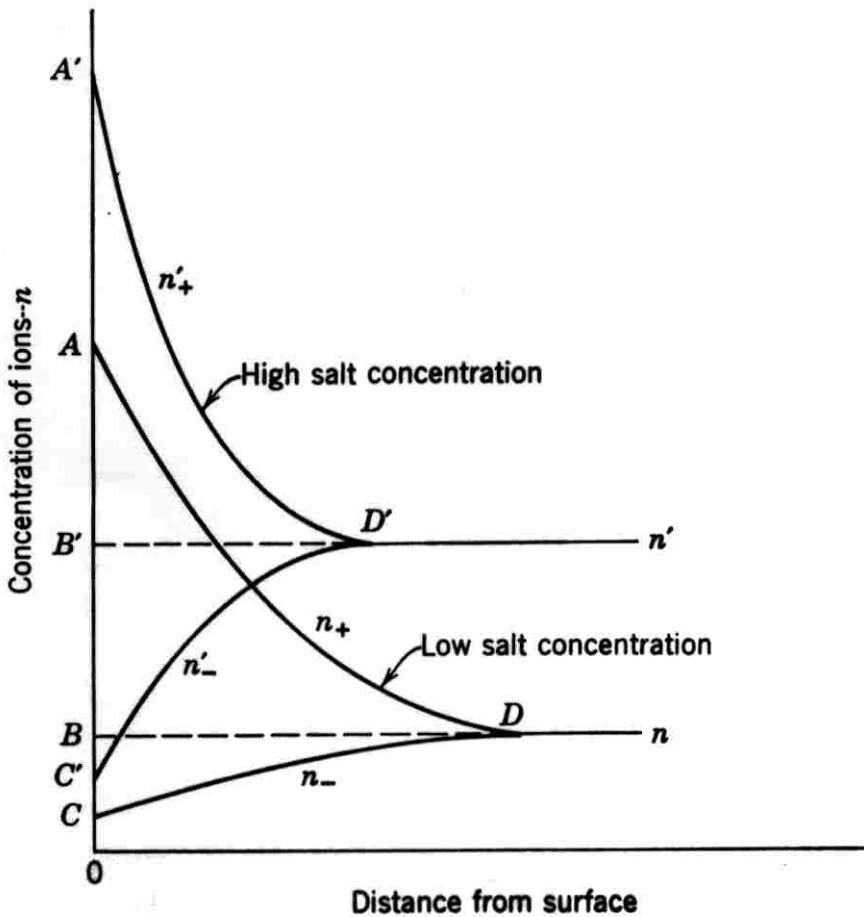
Manure Release

C_m & OD660



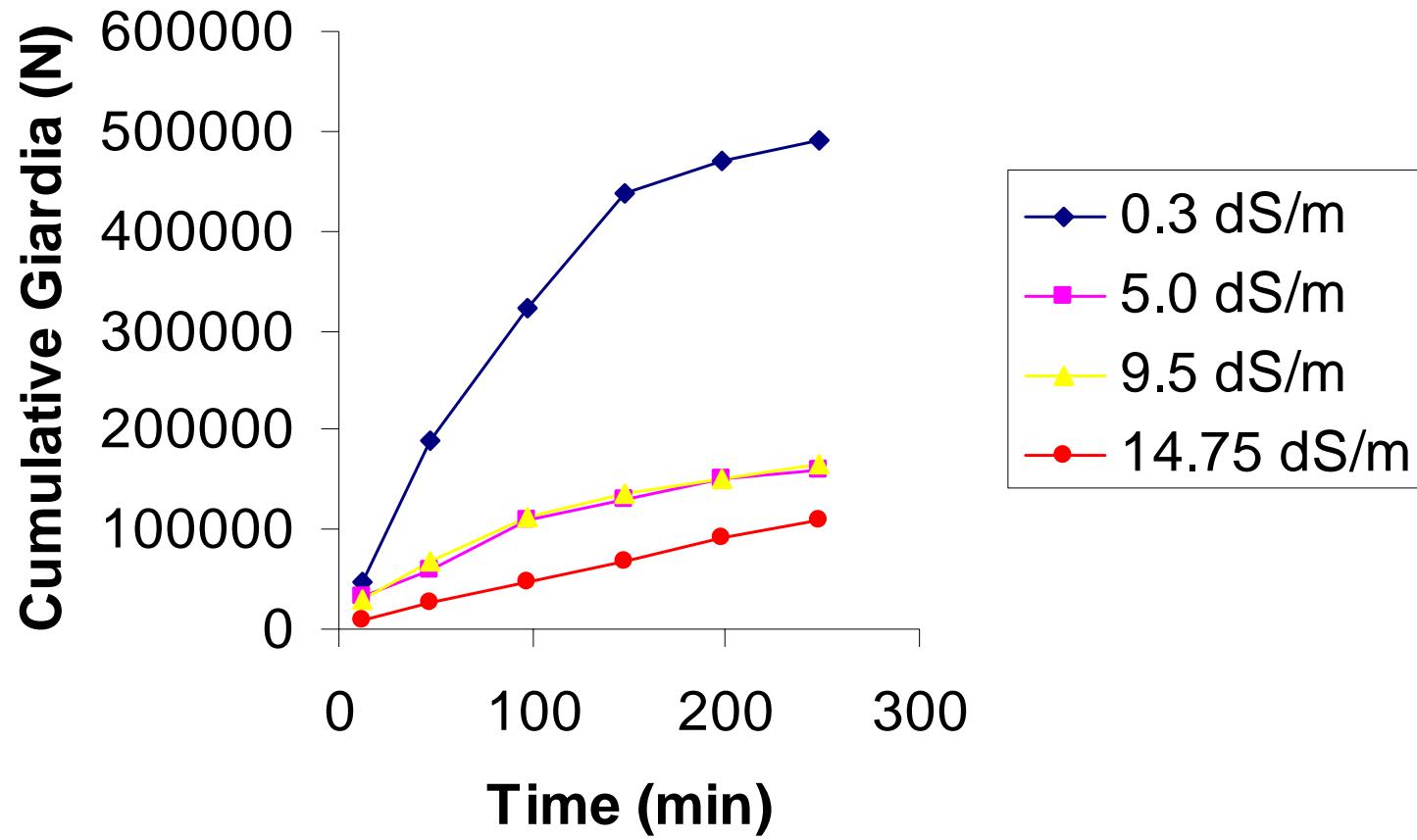


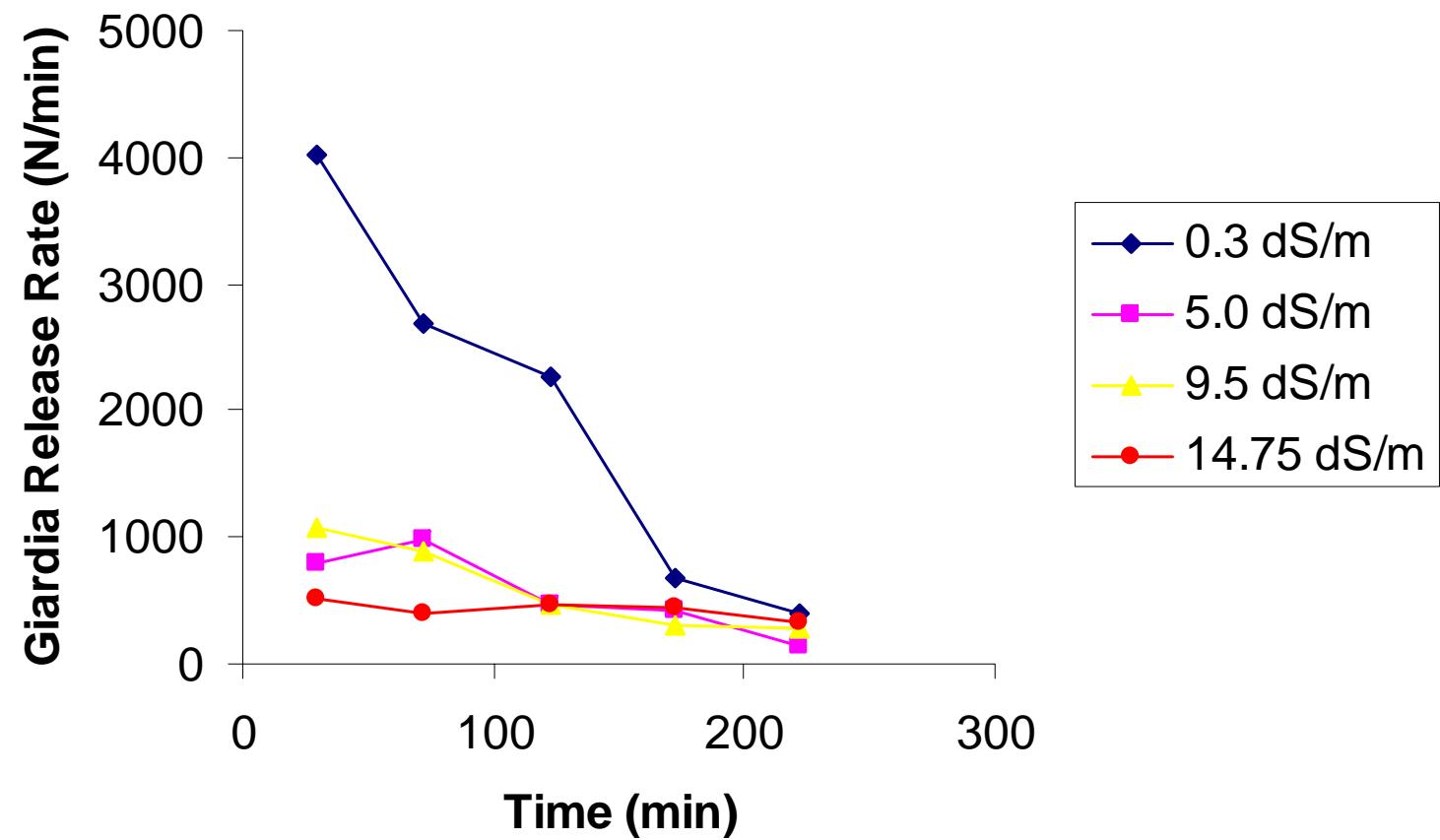


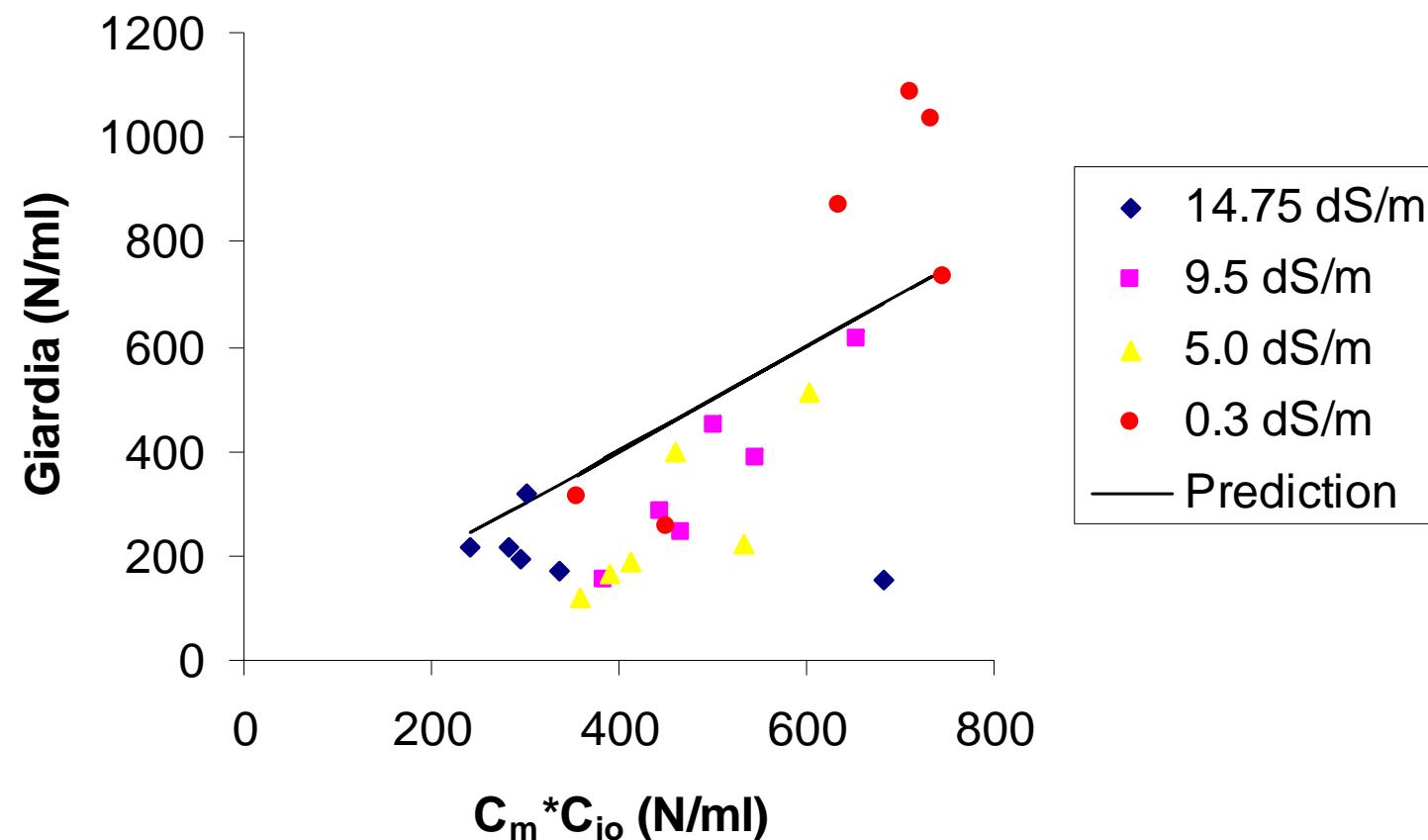




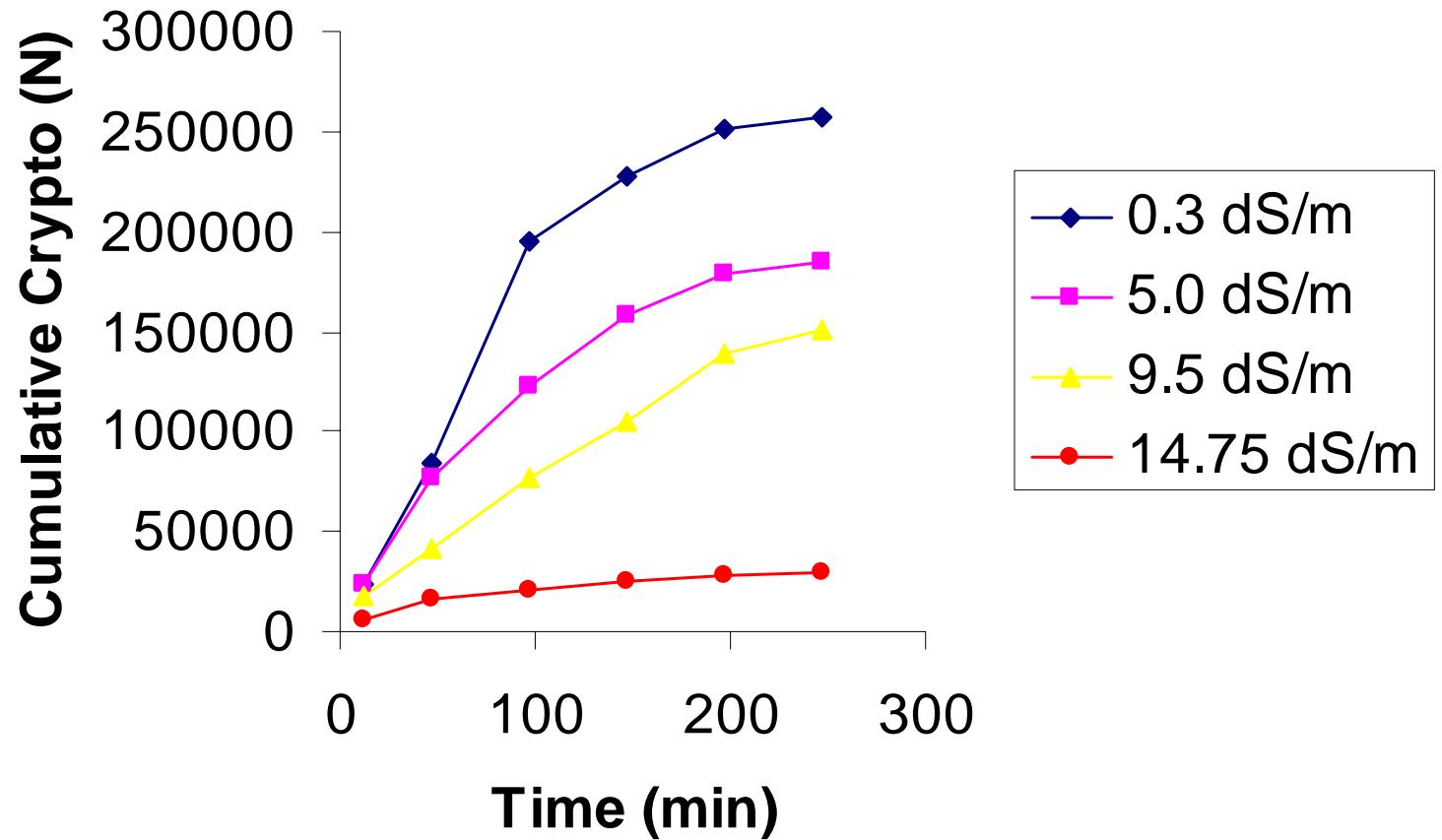
Giardia Release

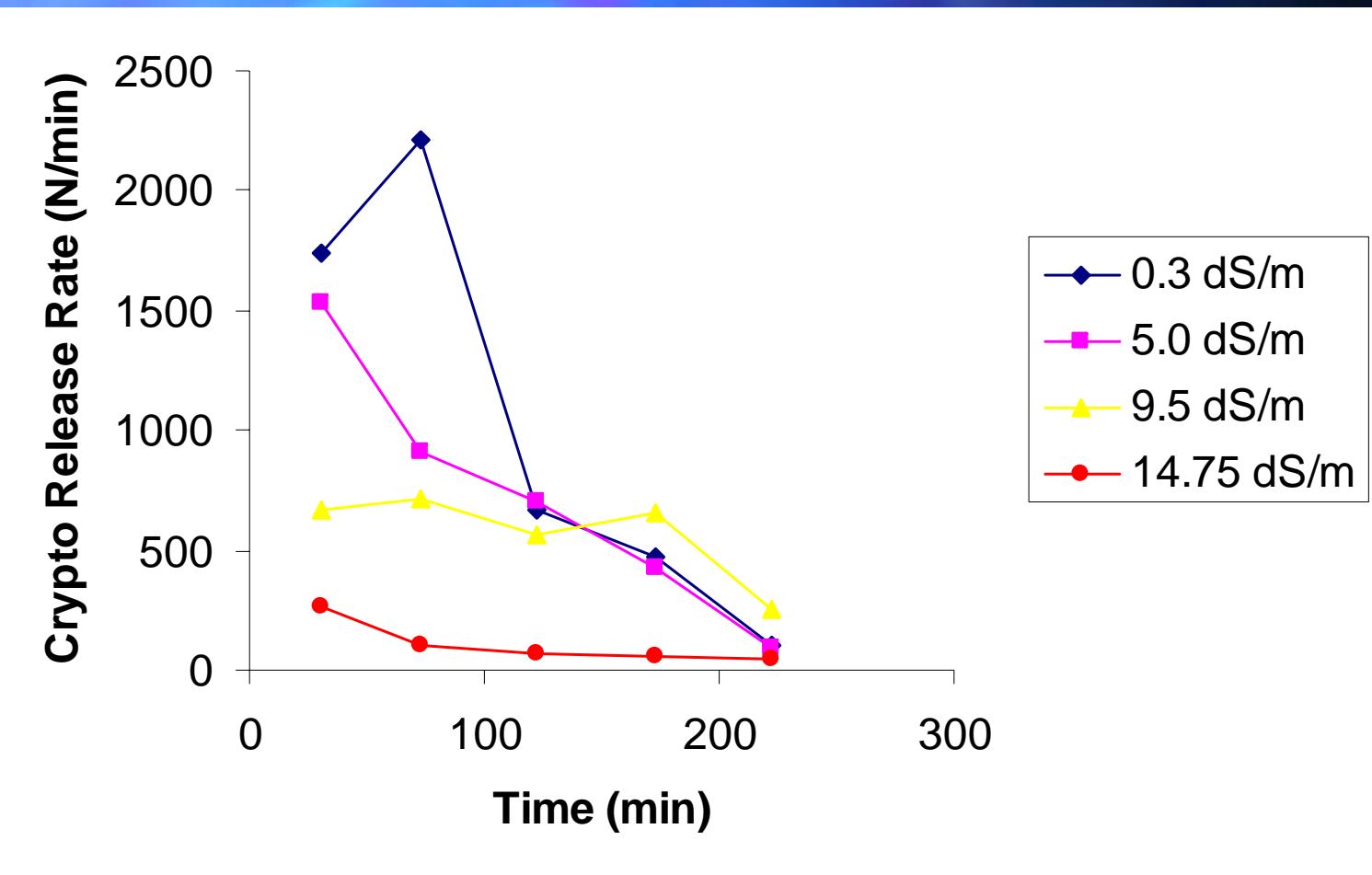


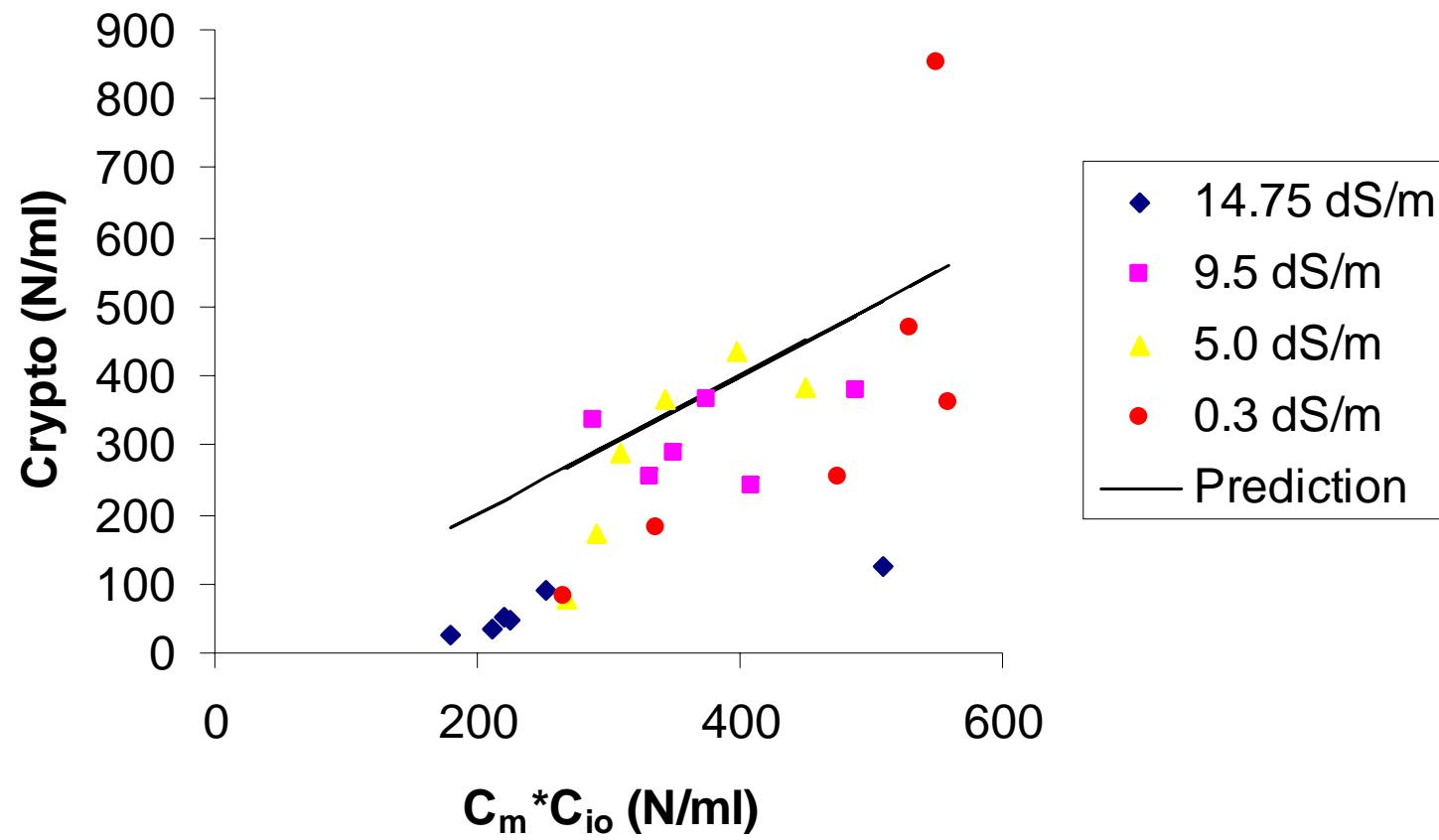


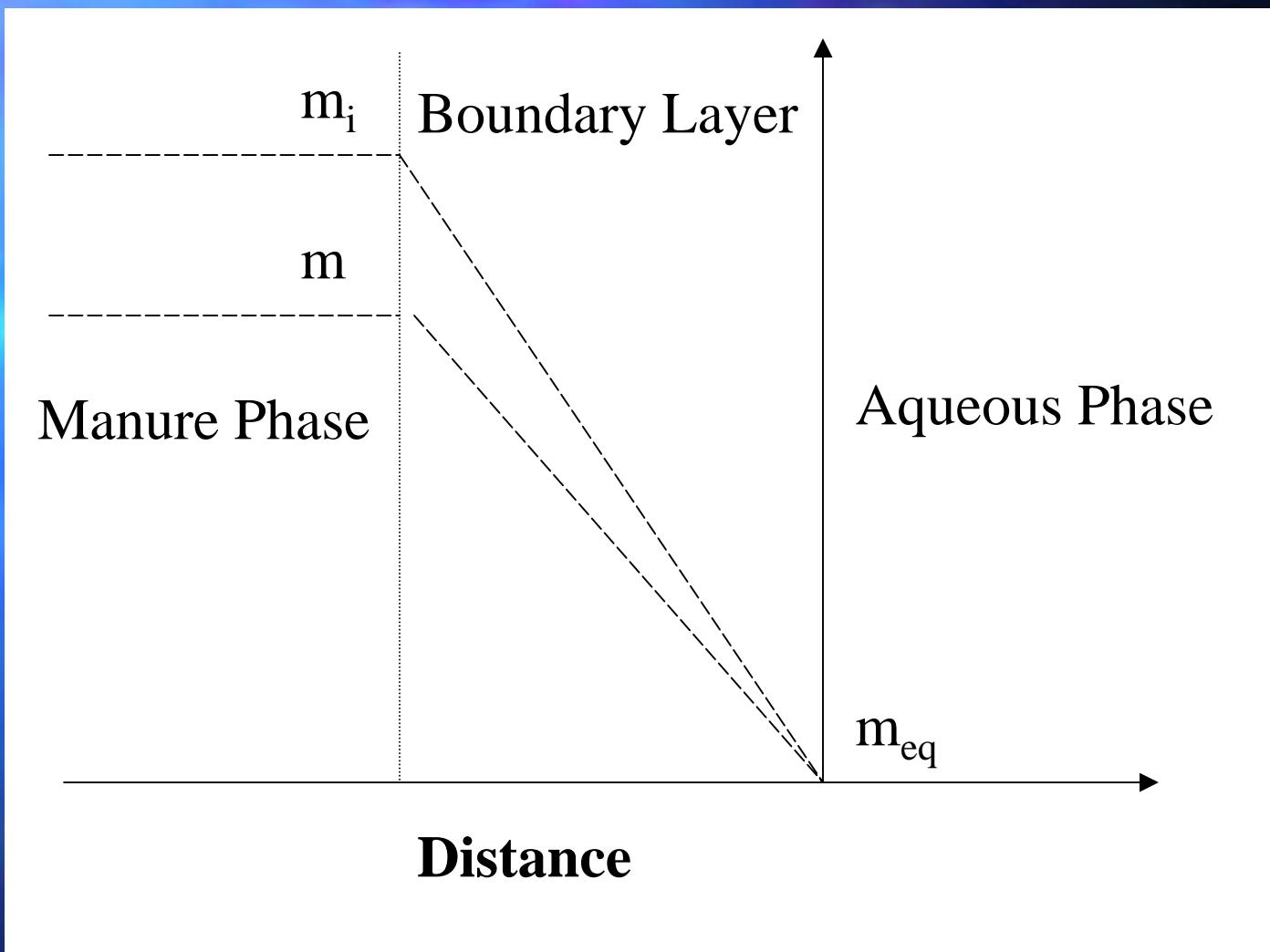


Cryptosporidium Release









Theory

$$\frac{dm}{dt} = k_{wm}[m_{eq} - m] \Rightarrow -k_{wm}m \Rightarrow -\alpha \left(\frac{m}{m_i} \right)^\beta m$$

$$m(t) = m_i (1 + \alpha \beta t)^{-\frac{1}{\beta}}$$

$$M_w(t) = V_m \cdot (m_i - m(t))$$

$$C_m(t) = \frac{dM_w}{Qdt} = \frac{m_i \alpha V_m}{Q} (1 + \alpha \beta t)^{-\frac{\beta+1}{\beta}}$$

$$C_o = C_{io} \cdot C_m \cdot E_{ro}$$

α - fitting parameter (T^{-1})

β - fitting parameter (-)

C_m - aqueous phase manure concentration ($M L^{-3}$)

C_{io} - initial manure phase (oo)cyst concentration ($N M^{-1}$)

C_o - aqueous phase (oo)cyst concentration ($N L^{-3}$)

E_{ro} - (oo)cyst release efficiency (-)

k_{wm} - lumped manure mass transfer coefficient (T^{-1})

m - bulk manure phase concentration ($M L^{-3}$)

m_{eq} - manure phase concentration in equilibrium with the aqueous phase ($M L^{-3}$)

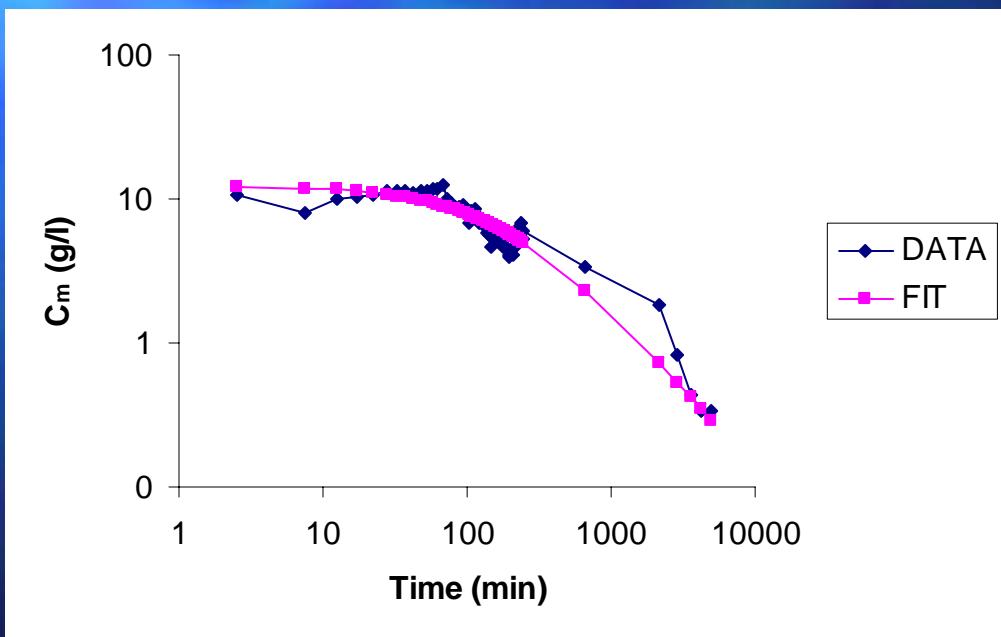
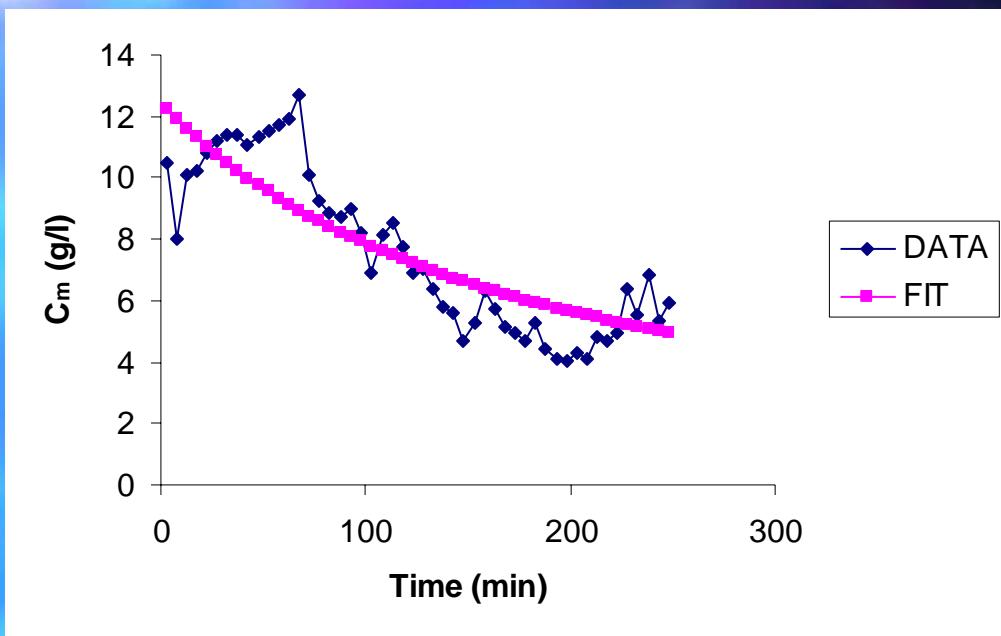
m_i - initial bulk manure concentration ($M L^{-3}$)

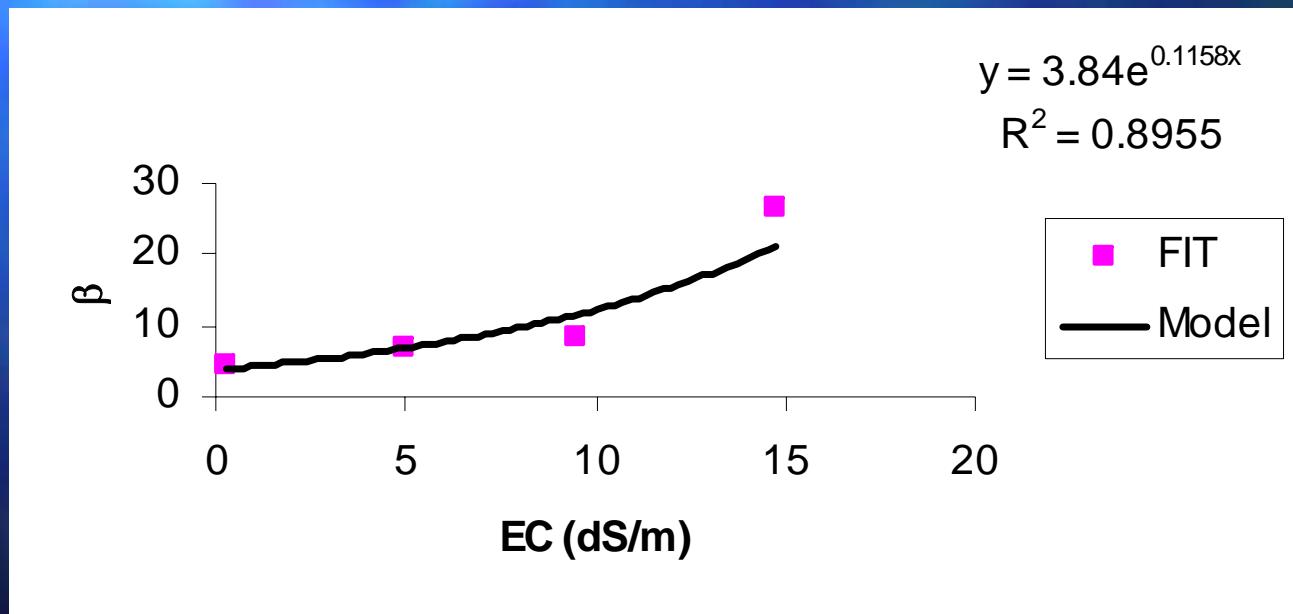
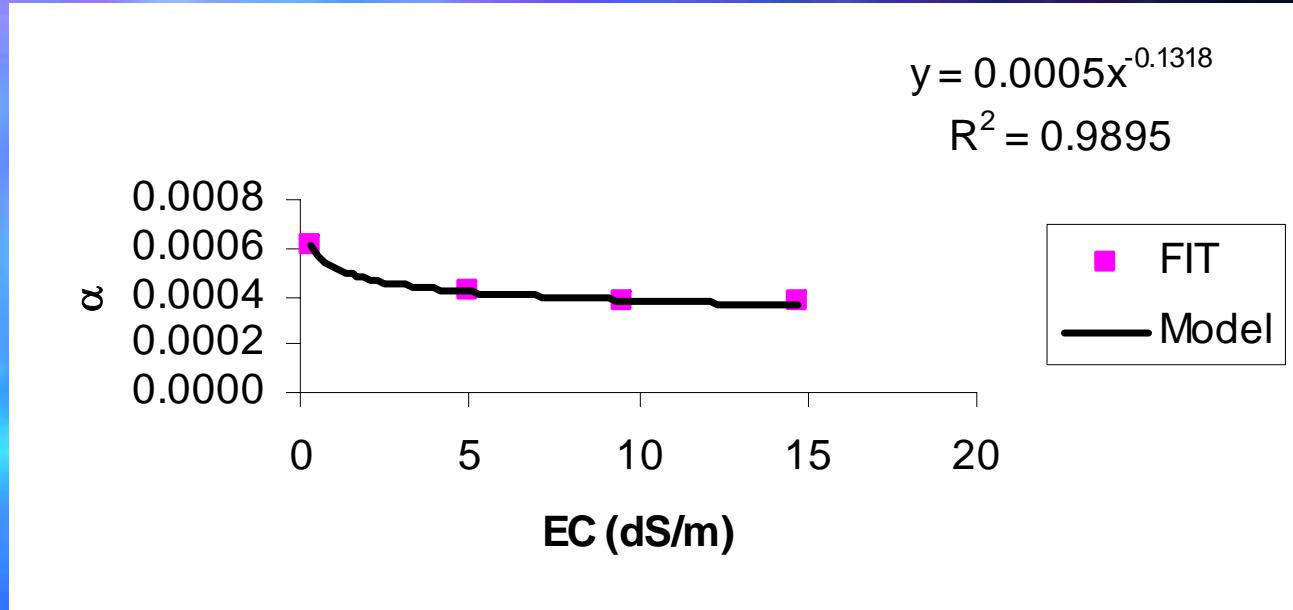
M_w - cumulative manure mass in the aqueous phase (M)

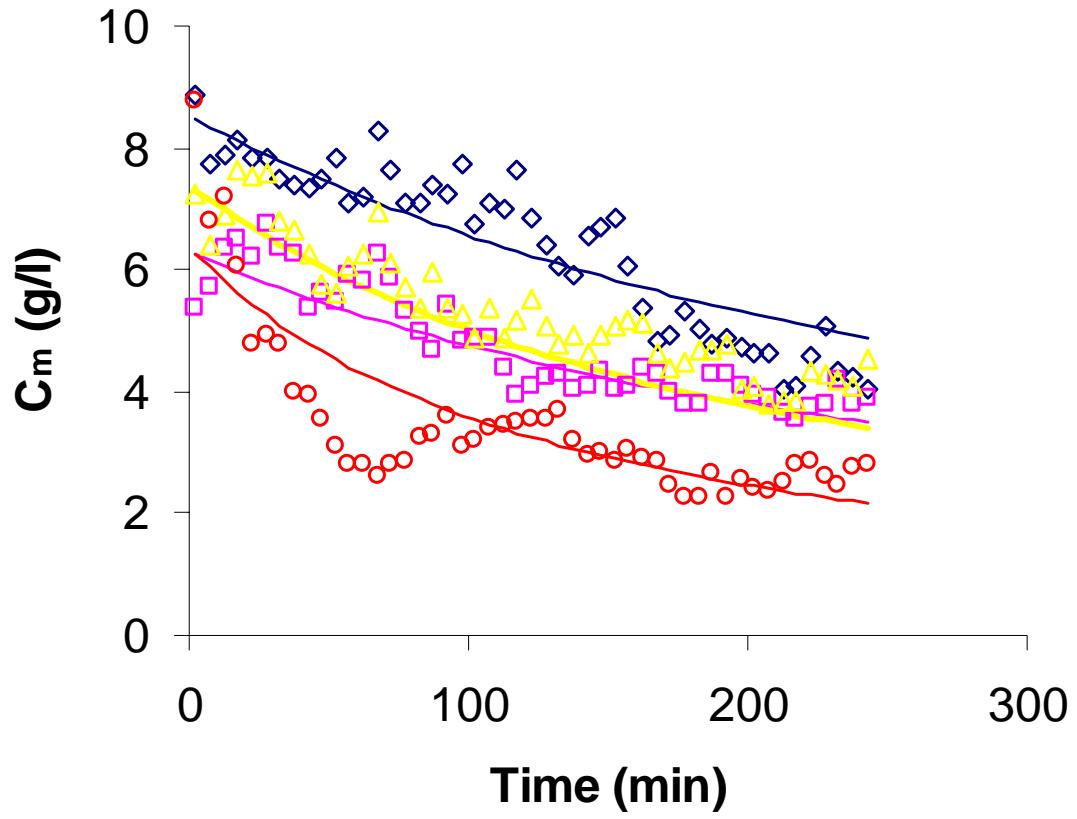
Q - aqueous phase flow rate ($L^3 T^{-1}$)

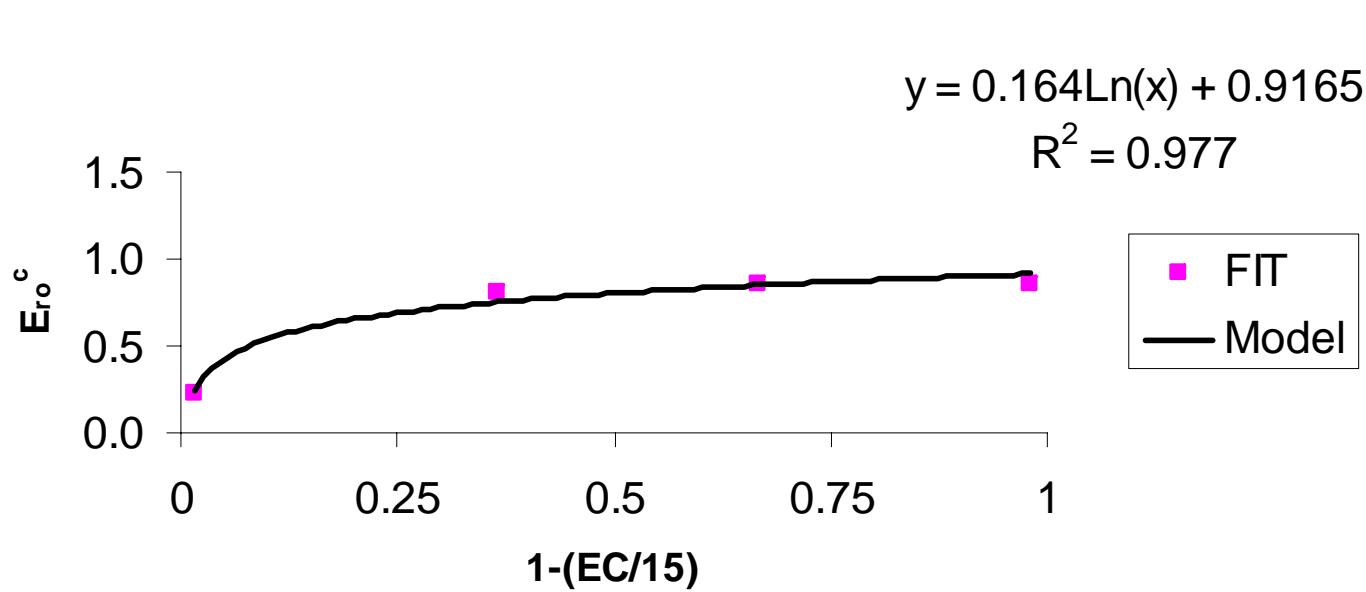
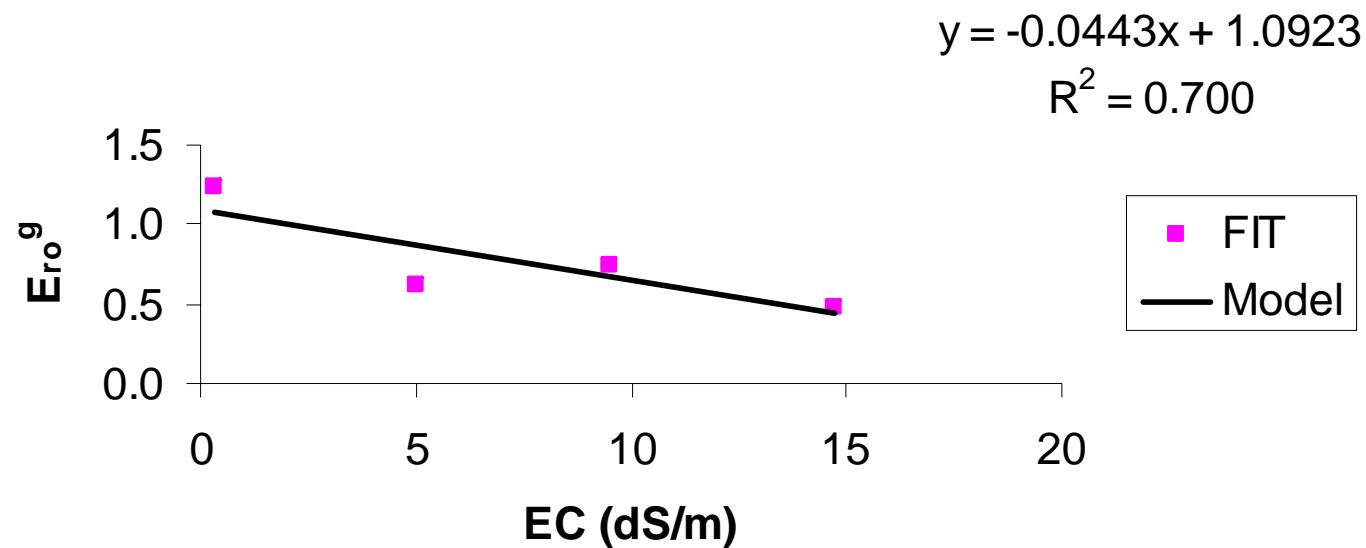
t - time (T)

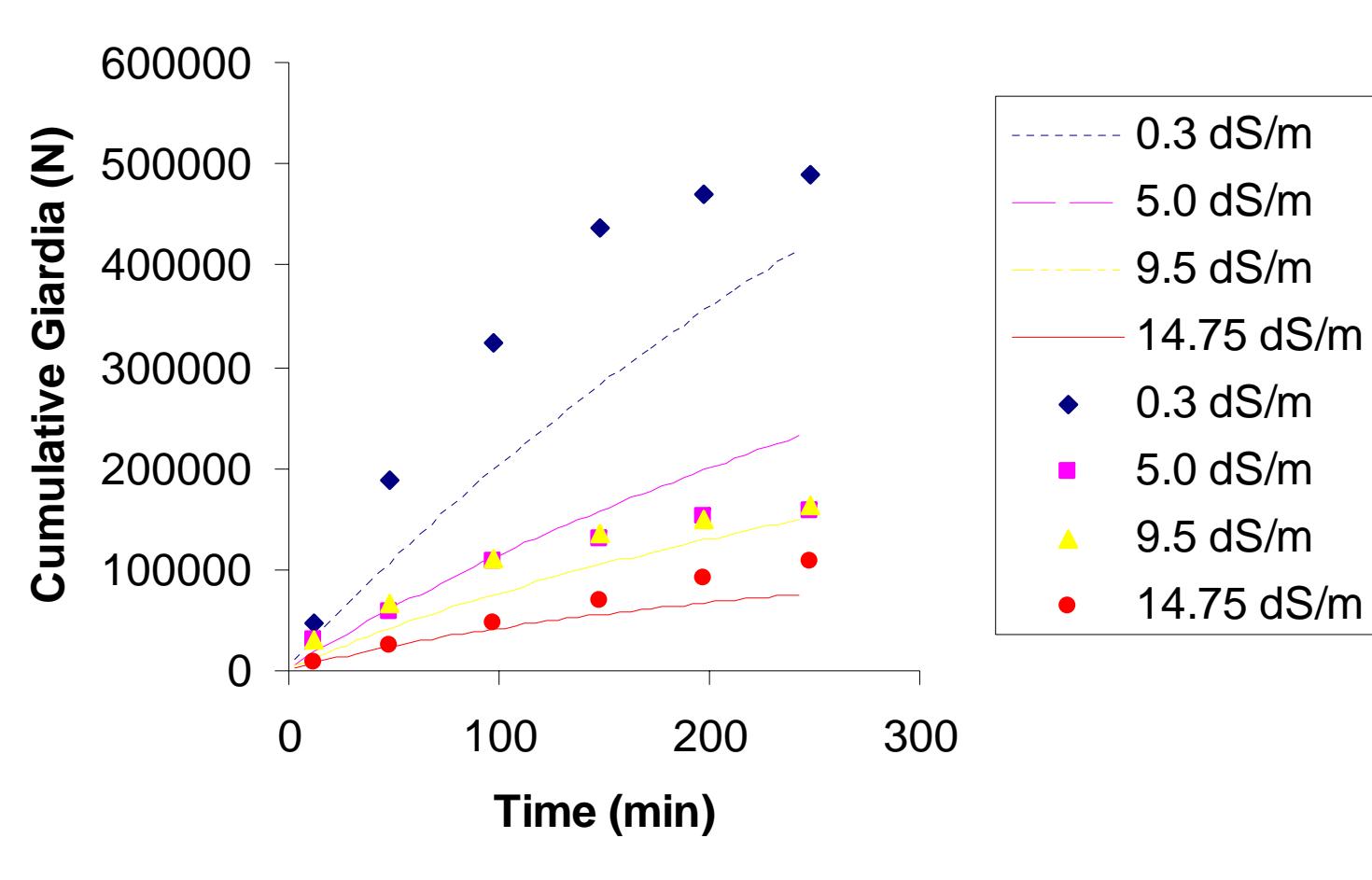
V_m - volume of manure (L^3)

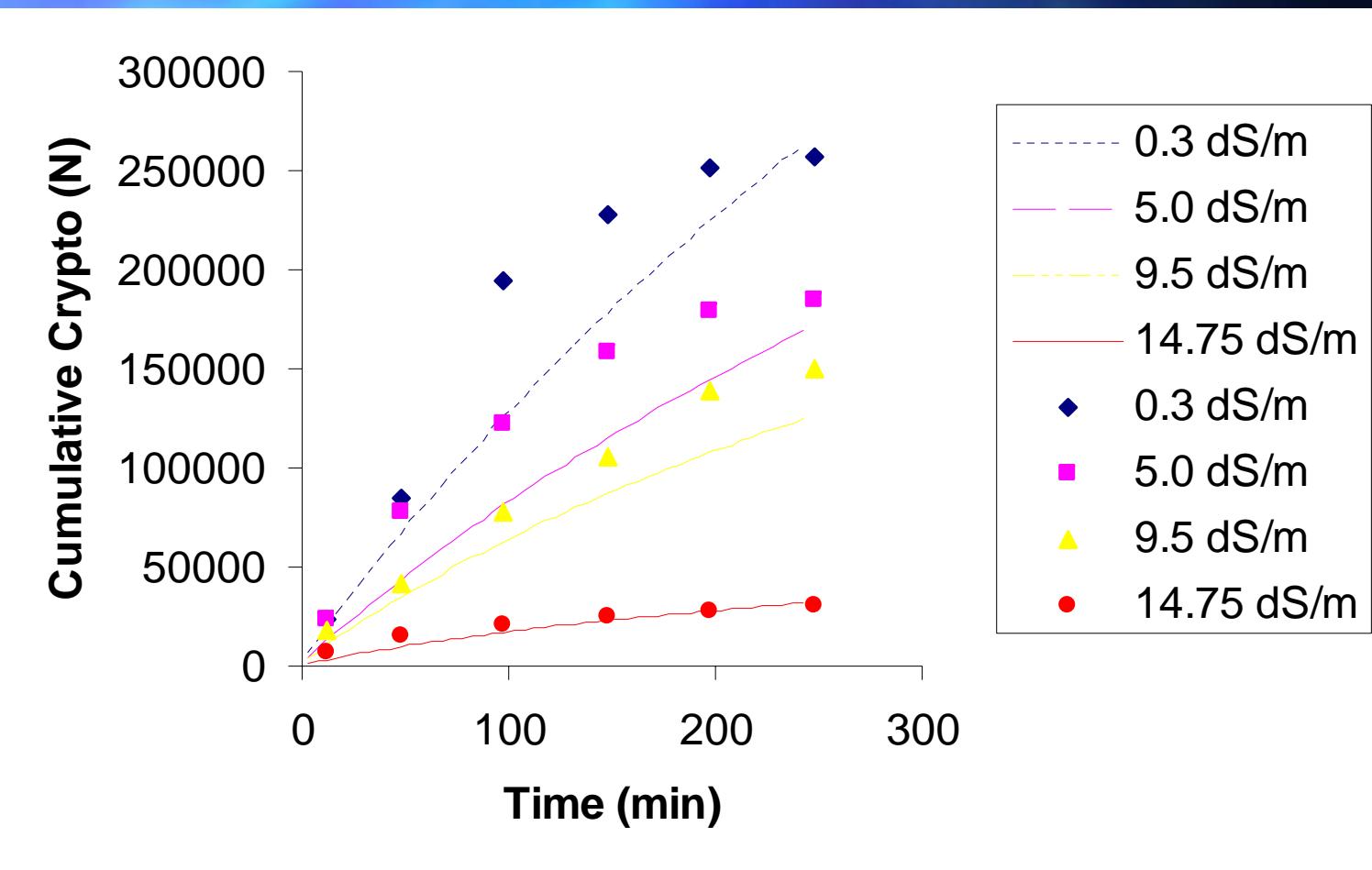












Conclusions

- Effluent concentrations of manure and (oo)cysts were initially several orders of magnitude below their initial concentration in the manure.
- Increasing the solution salinity tended to decrease the manure and (oo)cyst concentrations and, hence, the cumulative amount released into the aqueous phase.
- Increasing salinity was hypothesized to stabilize the manure by compression of the diffuse double layer thickness between negatively charged colloidal material in the manure.
- (Oo)cyst release efficiencies tend to decrease with increasing salinity.
- A conceptual model was developed to predict manure and (oo)cyst release and loading rates from manure.